A few more details on clays, Soil Colloids and their properties

How soils have charges 2 types of charges

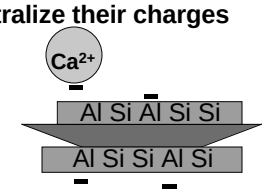
- Permanent charge
  - Isomorphic substitution
  - Phyllosilicate minerals
- pH dependant charge
  - Oxide minerals
  - Humus

Nature of charges on organic matter and oxides

- Not isomorphous substitution
- Result of functional group
- = O, OH on surface of colloid
- This means that the charges have different properties than those from isomorphic substitution
- You can't always count on them

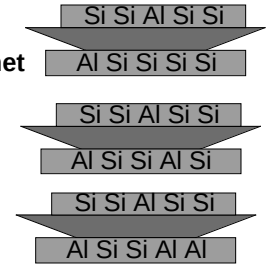
Charge from isomorphous substitution

- Cations (+) in soil solution will be attracted to surface of clay colloids to neutralize their charges



Fun is relative:

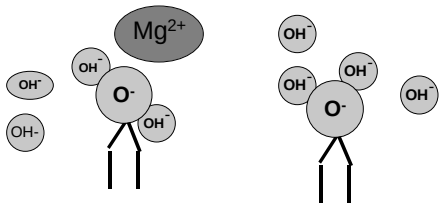
- Just for fun, Figure out the net charge on this mica



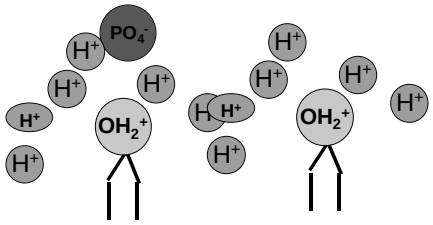
Back to oxide charges: Functional groups

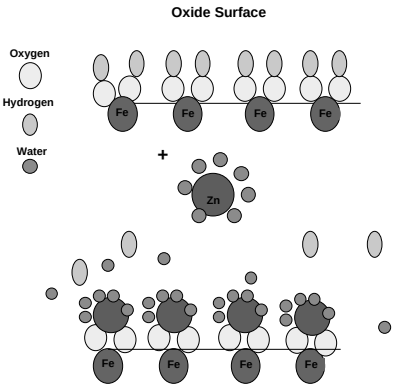
- Can attract cations at high soil pH
- Can attract anions at low soil pH
  - Not bisexual
  - amphoteric

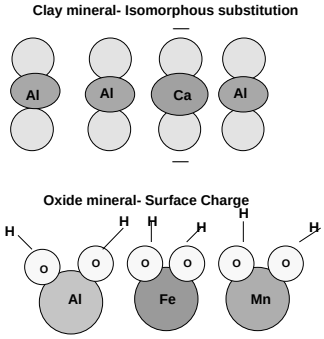
pH dependant charge
At high pH $(OH)^-$ pressure increases - cation adsorption



pH dependant charge
At low pH H^+ pressure increases Anion adsorption



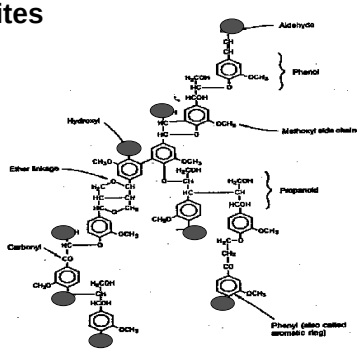




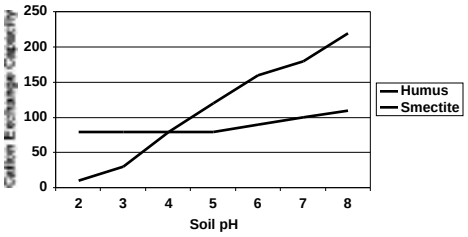
Soil organic matter

- **Has similar type of charges as oxides**
- **Number of cation adsorption sites will increase as pH increases**

Charge sites

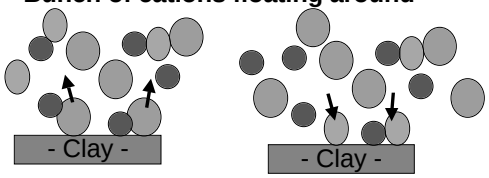


How charge can change



Cation exchange

- Soil solution is generally 0.01M in strength
- Bunch of cations floating around



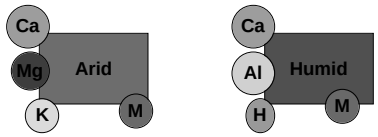
Cation exchange capacity (CEC)

- Amount of cations soil (all fractions) can hold
- Expressed as centimoles of charge per kilogram of soil
  - Centi = 100
- Reflective of
  - nutrient holding capacity of soil
  - Buffering capacity of soil

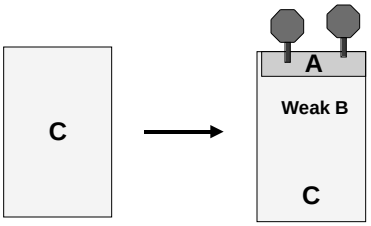
CEC of different types of soil

Soil order	CEC	pH
Ultisol	3.5	5.5
Alfisol	9.0	6
Spodisol	9.3	5
Mollisol	19	6.5
Aridisol	15	7.25
Vertisol	35	6.7

What it might look like

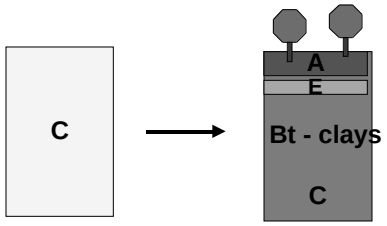


How weatherable minerals will affect soil formation



Coarse sand parent material

Sandy parent materials with a mix of weatherable minerals



Alfisol from sandstone and a range of weatherable minerals in CO

- High Smectite
- Near neutral pH
- Clay films, skins
- High nutrient holding capacity

Entisol from sandy glacial till in CT

- Highly acidic
- Some red color
- No clay films
- Low nutrient holding capacity

Physical properties of soils Brady and Weil Chap 4

Some physical properties

- Color
  - Mineral / organic content
  - Water relationships
- Texture
  - Water holding capacity
  - Workability
  - Nutrient holding/buffering

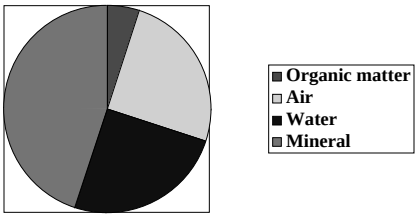
Organic matter

- Will tend to darken color of A horizon
- Also adds fertility
- So you have the association with rich black soil and fertility

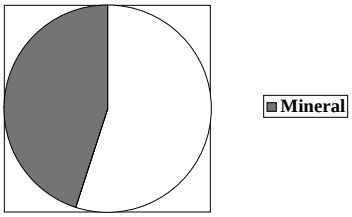
Color
What Fe does in soil

- With flooded conditions,
  - $Fe^{3+} \longrightarrow Fe^{2+}$
- If soil shows gleyed colors - sign of high water table

Soil texture
What soil consists of

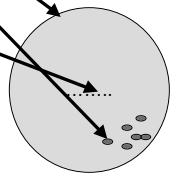


What the mineral fraction consists of



Three components:
(bigger than sand is coarse fraction)

- Sand - 0.02- 2 mm
- Silt - 0.002 - 0.02 mm
- Clay - < 0.002



Think of it as

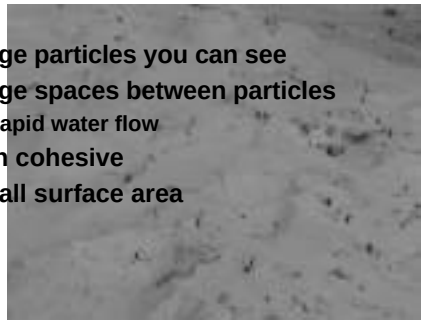
- Remember how big Horton was
  - Sand
- And how little the Whos down in Whoville were
  - Clay

But in this case

- Sand (Horton) who just sits there
- Clay (Whos) who make their presence felt

How to tell them apart: Texture by feel

Sand



- Large particles you can see
- Large spaces between particles
  - Rapid water flow
- Non cohesive
- Small surface area

Sandy Soils

- Low water holding capacity
  - Susceptible to drought
- Small surface area
  - Low CEC
  - Infertile
  - Easily acidified

Silt

- Small micro sand particles you can't see
  - Rapid weathering - nutrient release
- Small spaces between particles
  - water retention
- Non cohesive - can erode easily
- Higher surface area
  - More nutrient retention

Silty soils

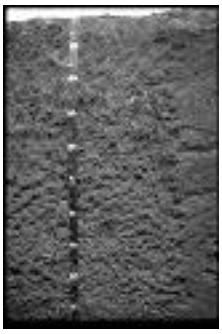
- Without vegetative cover
- 'can melt like butter'
- Soils formed from wind blown material (loess) are predominantly silt
- Fertile
  - Good water retention
  - Nutrient availability

Clay

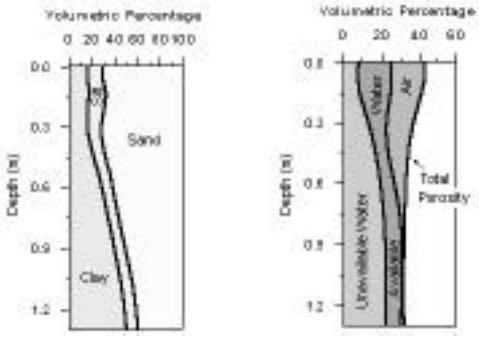
- Tiny particles, require special microscopes to see
- Very high surface area
  - Very reactive
  - High nutrient / water holding capacity
- Cohesive - can behave like plastic

Clayey soils

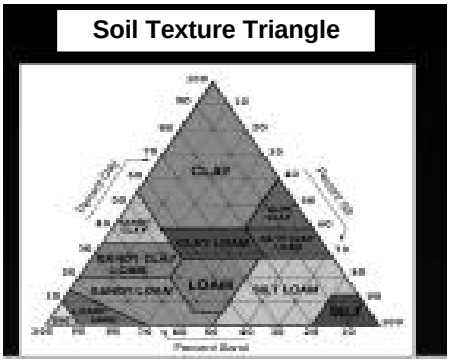
- Heavy soils
- Difficult tillage
- Water holding capacity is high
  - Water can be so tightly held to clay particles
  - Not plant available
- Slow drainage



Clay goes up, water goes down



Soil Texture Triangle



You get to do this in lab next week

Texture by feel method

Particle size doesn't change rapidly (in our lifetime)

- Aggregation is something you can influence